Space Weather Technical Forecast

Issued on Tuesday, 07 May 2024 at 01:29 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: M-class flares expected with chance of isolated X-class flares. Chance of G1-G2/Minor-Moderate storm intervals due to CMEs (coronal mass ejections).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity is at High levels. AR3663 has produced numerous M-flares and an X-class flare in the last 24 hours, reaching X4.5 at 06/0635 UTC. AR3364 is a larger region in the southeast but has been much less active. Ten sunspot regions feature on the visible disc, 8 numbered and two unnumbered. The most active remains AR3663, located in the northwest, displaying a large and complex intermediate spot with a delta configuration. AR3664 is the largest spot on the disc and located in the southeast and approaching centre disc. This also has a delta configuration. AR3668 just east of AR3644 remains beta-gamma in appearance with both active regions magnetically linked. The remaining sunspots on the disc are generally smaller, stable or in slight decay, and magnetically simple. A CME which originated from AR3663 in association with X4.5 flare at 06/0635 UTC may have an Earth directed component.

Solar Wind / Geomagnetic Activity: Solar winds observed by ACE at L1 were at slightly elevated to elevated levels following connection with a HSS after 06/0600 UTC, peaking at 593 km/s at 06/2324UTC. Density was at mostly average or slightly below average levels through the period. The Interplanetary Magnetic Field, Bt, remained mainly at moderate levels before declining to weak levels around 06/1730 UTC. The peak was around 17nT at 06/0614 UTC. The north-south component, Bz, was very variable but remained at weak to moderate levels in a range +14/-11 nT. Phi angle was mostly positive (away from the sun). Geomagnetic activity was Unsettled to Active (Kp 3-4) with a G1 Minor storm (Kp5) interval from 06/0000-0300 UTC, before returning to Quiet (Kp1-2) by 06/1800 UTC.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) observed at GOES18 was at normal background levels. High energy electron flux (greater than 2MeV) observed at GOES16 remained at largely background levels. The associated 24-hour fluence was well below the Active threshold. Observed fluence at 07/0001UTC was 1.38e6 integrated pfu on a slight upward trend.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate to High solar activity is forecast to continue with further M-flares expected and a chance of isolated X-flares, principally from AR3663 and AR3664.

Solar Wind / Geomagnetic Activity: There are multiple Earth-directed CMEs (coronal mass ejections) currently in the forecast period. A CME associated with the 04 May Moderate flare may give a glancing blow late early Day 1 (7th May). A CME associated with the 06 May X4.5 flare may cause an impact late Day 1/early Day 2 (7th-8th May). A third CME may impact sometime during Day 2 (8th May). Earth is under the influence of a HSS (High speed stream)

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from CH35/+ or CH33/+ which is expected to continue through Day 1 before slowly declining through Days 2 and 3.
Geomagnetic activity at Quiet to Unsettled levels (Kp1-3) with a chance of Active to Minor Storm (kp4-5) intervals in the event of CME enhancements, and perhaps reaching Moderate storm levels (Kp6). Activity should generally subside by day 3 (09 May) to reach mostly Quiet (Kp0-2) conditions by the end of the period.

Energetic Particles / Solar Radiation: High energy proton flux is most likely to remain at background levels through the period. There is a slight chance for an S1/Minor Storm or greater event throughout however, primarily from AR3663.
High energy electron flux is forecast to be at background to moderate levels throughout, with associated fluence expected to remain well below the Active (1e8 integrated pfu) threshold.

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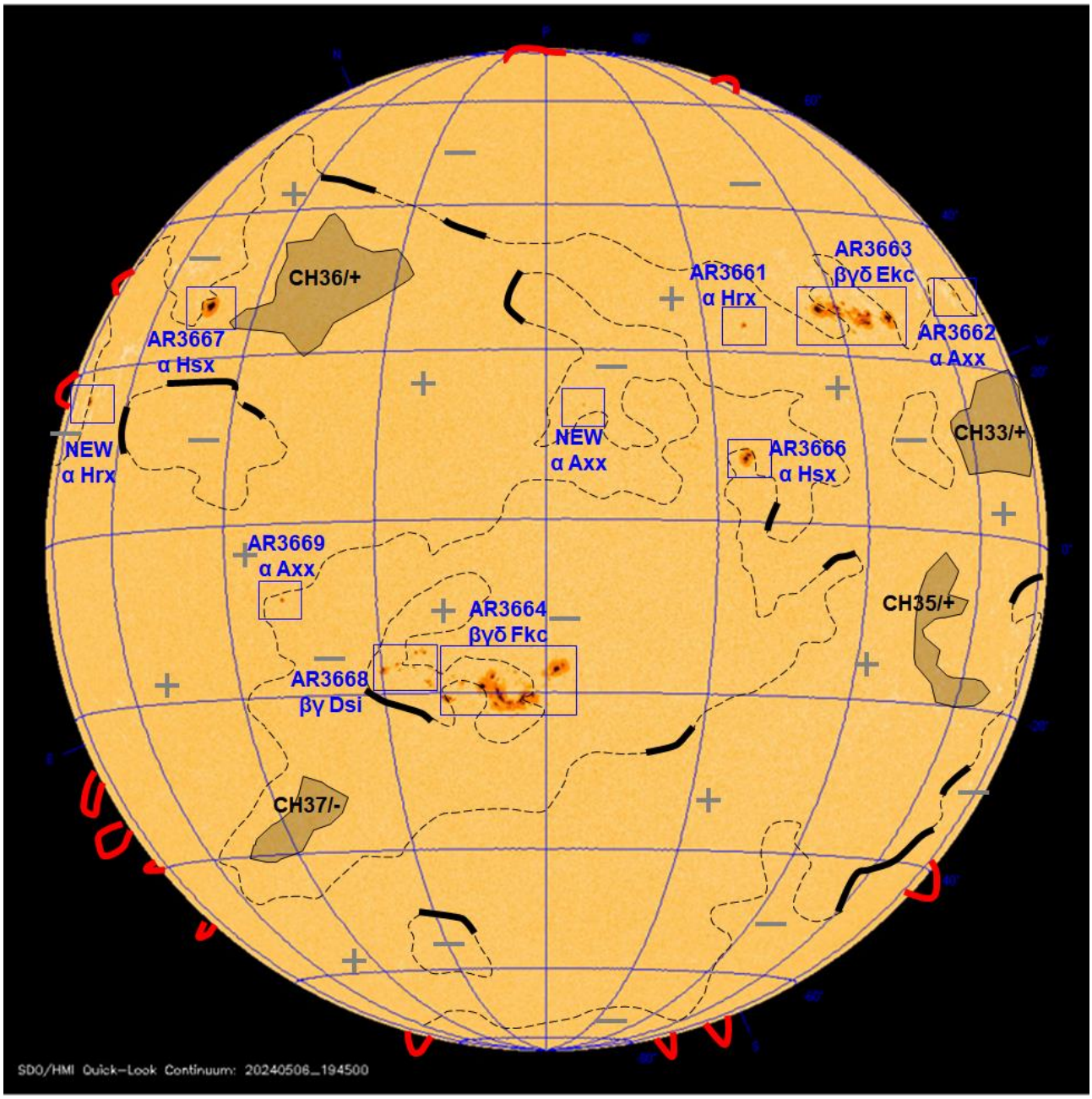
Figure 1. Solar Analysis Valid 2000 UTC, 6 May 2024.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There are multiple Earth-directed CMEs in the forecast period, although confidence is very low due to a recent lack of SOHO imagery. A largely northward directed CME followed the M9 flare on the 4th May, with modelling giving a possible glancing interaction early Day 1 (7 May). Another northbound CME in association with the X4.5 flare at 06/0635 UTC has the potential to have earth-directed components and cause an impact late Day 1 (7th May) but more likely early Day 2 (8 May) but again due to lack of imagery this is low confidence. A third CME may impact sometime during day 2 (8 May)

The earth is likely connected to a HSS from coronal holes CH33/+ and CH35/+, giving slightly elevated to elevated solar wind speeds. The coronal holes while broadly persistent are noticeably larger than the previous rotation and could see solar winds continue to peak into elevated levels days 1 and perhaps into the start of day 2 (06 and 07 May) before slowly declining, although any further CME influence may mask the signal. The combination of coronal holes and potential CME influence through the period, as well as gaps in imagery, results in a lower than average geomagnetic forecast confidence. Geomagnetic activity at Quiet to Unsettled levels (Kp1-3) with a chance of Active to Minor Storm (kp4-5) intervals in the event of CME enhancements, and perhaps reaching Moderate storm levels (Kp6). Activity should generally subside by day 3 (09 May) to reach mostly Quiet (Kp0-2) conditions by the end of the period.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	40	40	30	20
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
04/1125	Partial	AR3663	NE	650 km/s	07/1200 UTC	Glance possible
06/0930	Partial	AR3663	NE	900 km/s	08/1000 UTC	Glance possible

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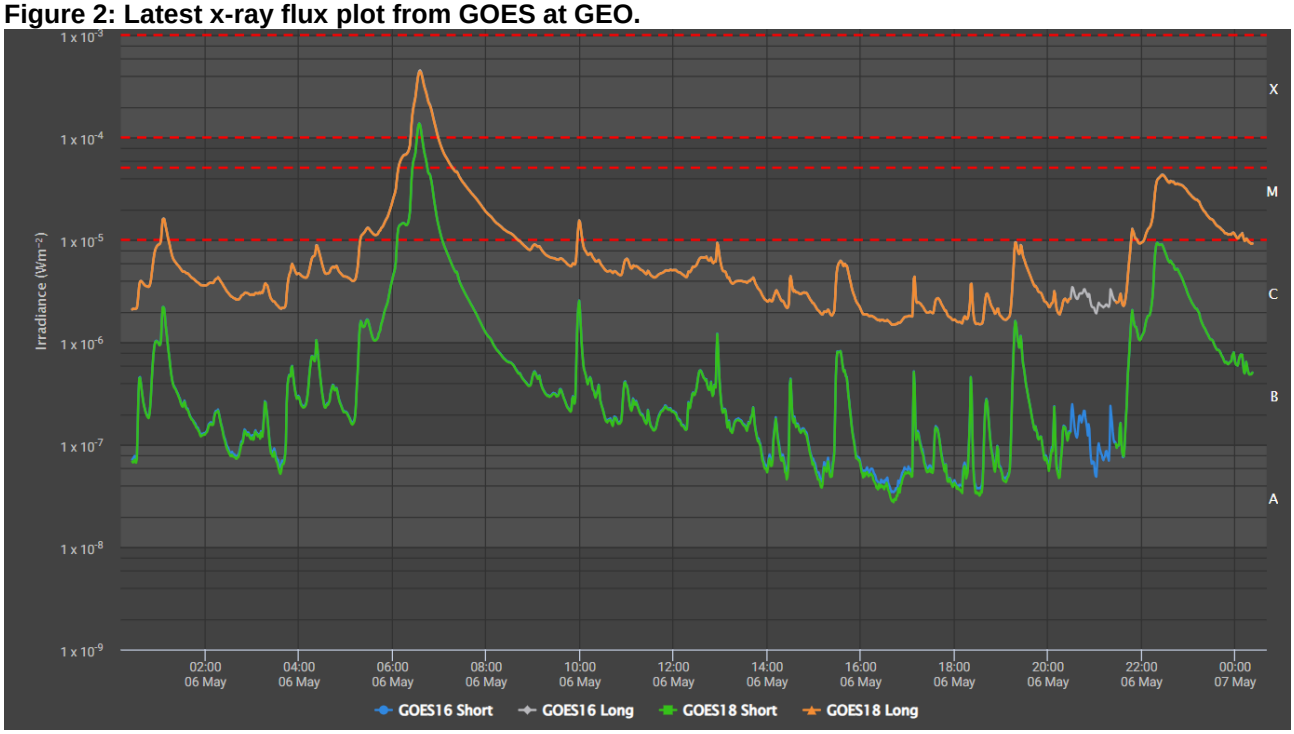
Figure 2: Latest x-ray flux plot from GOES at GEO.



Radio Blackouts - X-Ray Flares:

Solar activity is High and AR3663 has produced numerous M-class flares and an X-flares in the last 24 hours, which reached X4.5 at 06/0635 UTC AR 3664 in the southeast has been much less active although is larger.

There are currently ten numbered sunspot regions on the visible disc. The most active remains AR3663, located in the northwest, and which features a large and complex intermediate spot with a delta configuration. AR3664 is the largest spot on the disc and located in the southeast and is approaching centre-disc, also with a delta configuration in its southern intermediate spot, where the bulk of the recent areal growth has occurred. AR3668 is just to the east of AR3644 and has increased in size and complexity in recent hours, AR3664 and AR3668 also appear to be magnetically linked. The remaining sunspots on the disc are generally smaller, stable or in slight decay, and magnetically simple. Both AR3663 and AR3664 remain on the visible disk for much of the guidance period, and far-sided helioseismographs indicate a number of returning regions over the eastern horizon in the coming days that may supplement the present risk of significant flares should they persist.

Moderate to High solar activity is expected to continue, pending further developments, with occasional M-class flares and a chance of isolated X-class flares throughout, principally from AR3663 and perhaps to a lesser extent AR3664.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	90	90	90	90
Very Active	R3 to R5 X Class	Yes	30	30	20	20

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Solar Radiation Storms - (High Energy Protons):
High energy proton flux (greater than 10MeV) observed at GOES-18 has been at background levels and is most likely to remain that way through the period. However, there is a chance of an S1/Minor Storm or greater event occurring throughout, primarily from AR3663 as it transits westward, although recent significant flares from this region have so far failed to trigger any significant proton response.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	20	20	30	30
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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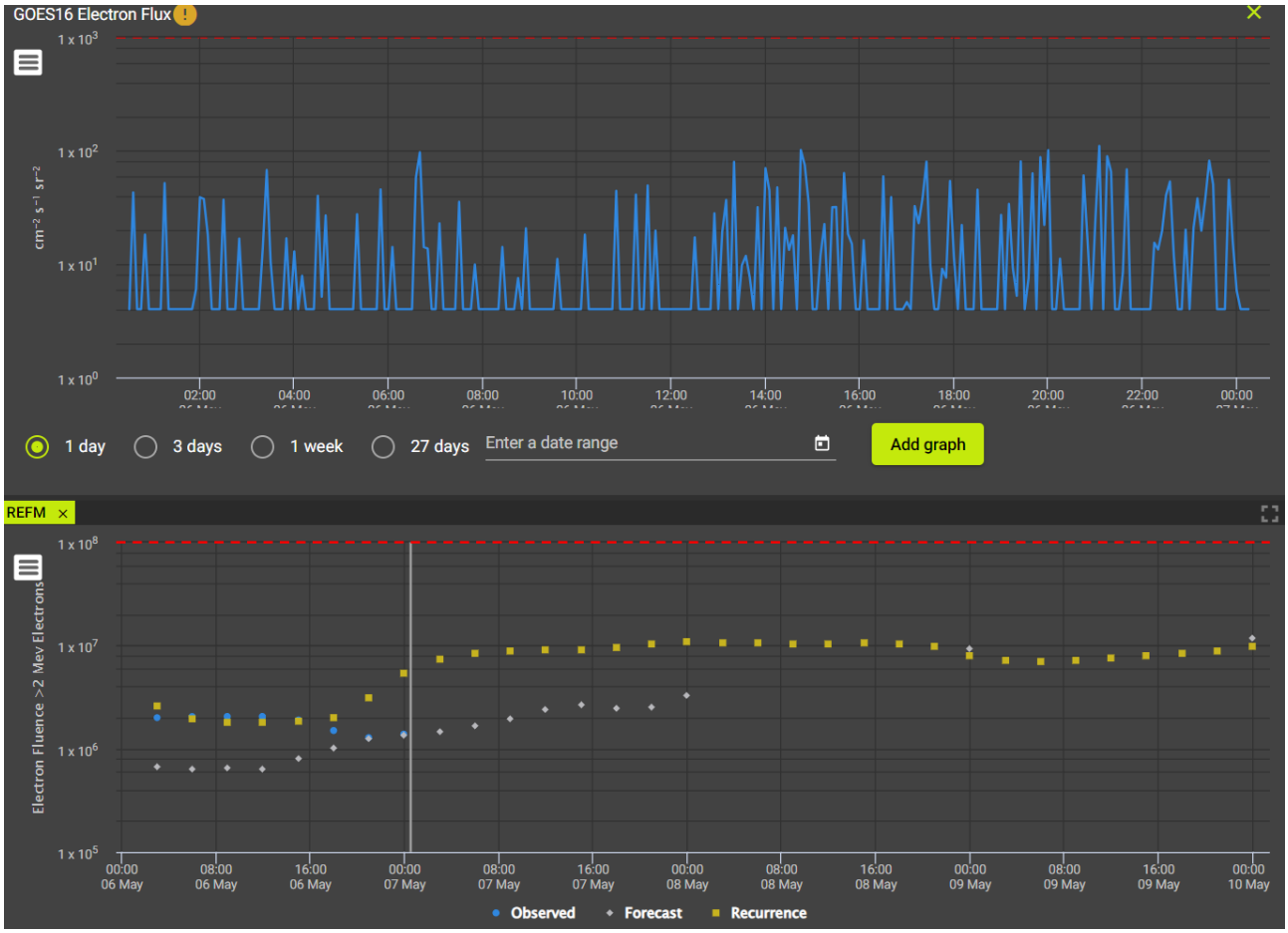
High Energy Electrons Event (≥ 2MeV):
High energy electron flux is at normal background levels. Likely CME and coronal hole influences through the period are expected to limit electron flux at background to moderate levels on all days.
Overall, the 24 hour integrated electron fluence is forecast to remain well below the Active (1e8 integrated pfu) threshold.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	1	1	1
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 3:High energy electron flux and Met Office REFM output.



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